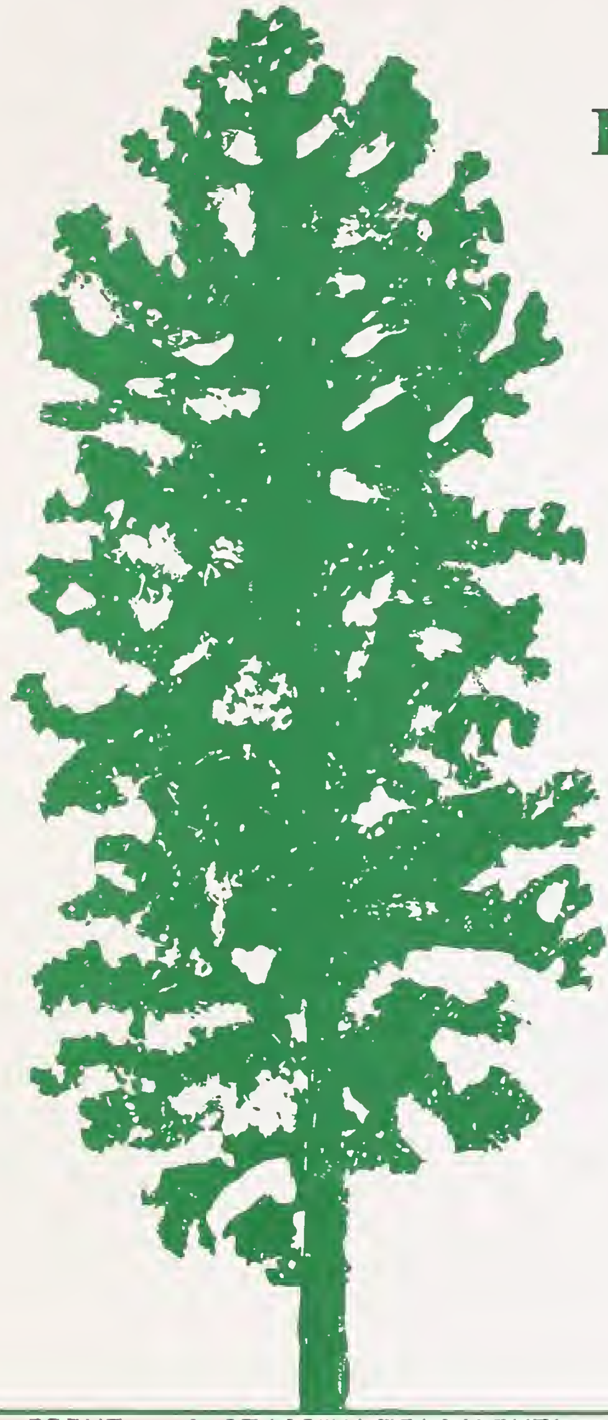

RMYLD: Computation of Yield Tables for Even-Aged and Two-Storied Stands

Carleton B. Edminster

Research Paper RM-199
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Abstract

Documents a program for computation of yield tables for even-aged and two-storied stands of Black Hills and southwestern ponderosa pine, Engelmann spruce-subalpine fir, and even-aged stands of lodgepole pine. Alternatives include a wide range of stand densities and management controls. Program relationships provide for changes in stand conditions and severity of dwarf mistletoe infestation with time and in response to partial cuttings. Supersedes programs LPMIST, PONYLD, SPRYLD, and SWYLD2, published as USDA For. Serv. Res. Pap. RM-72 (1971), RM-79 (1971), RM-134 (1975), and RM-163 (1976). Also supersedes USDA For. Serv. Res. Pap. RM-21 (1966), RM-26 (1967), RM-43 (1968), and RM-87 (1972).

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Management Highlights

Computer program RMYLD described in this paper has been developed to compute yield tables for the following species, areas, and stand conditions:

1. Even-aged and two-storied stands of ponderosa pine (*Pinus ponderosa* Laws.) in the Black Hills of South Dakota and Wyoming.

2. Even-aged stands of lodgepole pine (*P. contorta* Dougl.) in Colorado and southern Wyoming, including effects of dwarf mistletoe (*Arceuthobium americanum* Nutt. ex Engelm.).

3. Even-aged and two-storied stands of ponderosa pine in Colorado, Arizona, and New Mexico, including effects of dwarf mistletoe (*A. vaginatum* subsp. *cryptopodum* (Engelm.) Hawksw. & Wiens).

4. Even-aged and two-storied stands of Engelmann spruce (*Picea engelmannii* Parry)-subalpine fir (*Abies lasiocarpa* (Hook.) Nutt.) in the central and southern Rocky Mountains.

Users of published programs to compute yield tables listed below have recognized the need for a capability of handling a wider range of stand conditions and management alternatives. Some of the original relationships and computational procedures have been modified, and new ones have been added. Program RMYLD has been written to supersede the following programs:

1. PONYLD (Myers 1971) published as USDA Forest Service Research Paper RM-79.

2. LPMIST (Myers et al. 1971) published as USDA Forest Service Research Paper RM-72.

3. SWYLD2 (Myers et al. 1976) published as USDA Forest Service Research Paper RM-163.

4. SPRYLD (Alexander et al. 1975) published as USDA Forest Service Research Paper RM-134.

Earlier procedures for calculating yield tables contained in USDA Forest Service Research Papers RM-21 (1966), RM-26 (1967), RM-43 (1968), and RM-87 (1972) are also superseded.

Modifications and additions now provide these features: (1) yield tables are computed for even-aged stands or for each story of two-storied stands except lodgepole pine; (2) average diameter and height growth equations apply to a wide range of stand densities; (3) an intermediate or regeneration cut is no longer required at the initial age printed in the yield table; (4) equations are included to compute merchantable cubic feet produced as a byproduct of a sawlog cut; (5) the program is written to examine a series of intermediate cutting alternatives for only one set of stand data; (6) separate regeneration cut controls may be specified for each story of two-storied stands; (7) growing stock level to be retained for regeneration cuts may be based on stocking level for subsequent intermediate cuts or basal area present before the first cut; (8) provision is made to account for logging damage to the understory in two-storied stands; (9) the program will compute and print initial stand conditions and estimate stand conditions for up to twenty-nine 10-year growth projection periods; (10) format statements allow tables to be generated on printers with either 80 or 132 character-width lines; (11) the user may specify whether input and output data are to be expressed in U.S. customary or System International metric units; and (12) relationships for other tree species and pests may be included in RMYLD by simply adding another species-specific subroutine and making a few minor changes as discussed in the Program Modification section.

RMYLD is a whole-stand, distance-independent model. The advantages of such a model are the ability to utilize conventional inventory data, relative simplicity, and fast computation time. The major disadvantage is that specific individual tree information is lacking (Munro 1974). To reduce computation time RMYLD uses 10-year growth projection periods rather than annual increments.

RMYLD is written in standard FORTRAN IV and can be run on almost any computer that provides 50,000 octal memory locations. Yield tables can be produced at a cost of about 5 to 10 cents each, excluding cost of program compilation.

A listing of the program and/or a source deck may be obtained from the Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colo. 80521.

Program Application

Stands to be examined using RMYLD should be even-aged or two-storied. In even-aged stands, diameters of most trees will not differ greatly from the average diameter of the stand. Although the range of tree diameters in an even-aged stand will increase with stand age and time since treatment, stands with a range in diameters greater than 12 inches may not be even-aged (Hawksworth and Myers 1973) and may have to be treated as two-storied. Two-storied stands will appear to be two-aged, and ages of trees in the smaller diameter classes will be much less than ages of trees in the larger diameter classes. Two-storied stands may occur naturally or may result from a seed cut of a shelterwood followed by regeneration under the residual overstory.

The stand must be consistent in species composition, site quality, stand structure, tree density, and past treatment. In infested stands, dwarf mistletoe should be distributed uniformly over the area. If part of the area is free of dwarf mistletoe, it should be treated as a separate stand. Stands of any size may be analyzed, since the yield tables give values for an average acre or hectare. Uniformity of site quality and stand characteristics must be such that site index and other area averages precisely describe the unit of forest analyzed. Stand area may range from a few acres in rough terrain to 100 or more acres where meaningful averages may be computed (Myers et al. 1976).

Occasional trees of species other than those for which program relationships are valid may be present in the stand being analyzed. The amount of species variation that may exist before precision is significantly reduced will depend on the relative growth rate of the species (Hawksworth and Myers 1973). Generally no more than 10% of the trees should be of different species. Aspen (*Populus tremuloides* Michx.) can occur as a minor species in stands of ponderosa pine, lodgepole pine, or spruce-fir. On poorer sites, aspen generally will not achieve merchantable size, and should be excluded from input data. On sites where aspen can achieve merchantable size, it should be included in the input data. In this situation, the program user should make adjustments in stand volume for conifers based on estimated proportion of aspen in total stand basal area.

RMYLD contains reductions in growth rates for mature and overmature stands. These reductions are based on experience from samples of inventory data, since no formal studies on growth rates for overmature stands have been conducted. When simulating no management, users are cautioned to compare growth rates computed by RMYLD with growth rates from local inventory data. In some cases, RMYLD may show excessive yields when simulating no management for mature and overmature stands.

Bruce (1977) presents an excellent discussion of the reasons for differences in timber yields from research study plots and forest stands. This article is recommended for anyone wishing to apply RMYLD to forest conditions.

Dwarf Mistletoe

The effects of dwarf mistletoe in reducing tree growth and increasing mortality in lodgepole pine and southwestern ponderosa pine stands have been discussed in the papers documenting programs LPMIST (Myers et al. 1971) and SWYLD2 (Myers et al. 1976). Both of these cite numerous references dealing with specific aspects of infestation by dwarf mistletoe. The effects of dwarf mistletoe (*Arceuthobium microcarpum* (Engelm.) Hawksw. & Wiens) on Engelmann spruce in Arizona and New Mexico are not included in RMYLD.

Dwarf mistletoe infestation is measured by the 6-class rating system (Hawksworth 1977). This system actually uses seven classes, since healthy trees are given a rating of 0. The designation of "6-class system" has been widely used, however, and will be used in this paper. A rating is obtained for each live tree (fig. 1). In even-aged stands, the individual tree ratings are then averaged to obtain the value for the entire stand. In two-storied stands of southwestern ponderosa pine, separate averages are computed for the overstory and understory.

RMYLD allows information on the dwarf mistletoe infestation to be reported in one of three ways for an even-aged stand, or for each story in a two-storied stand: (1) average dwarf mistletoe rating (DMR), (2) percentage of infected live trees (PINF) in unthinned stands, or (3) average age at time of initial infestation (START). Only one of these three alternatives should be used to report information on the infestation. If possible, DMR or PINF should be used. Walters and Brown (1973) and Walters and Geils (1977) describe sampling methods for determining the percentage of in-

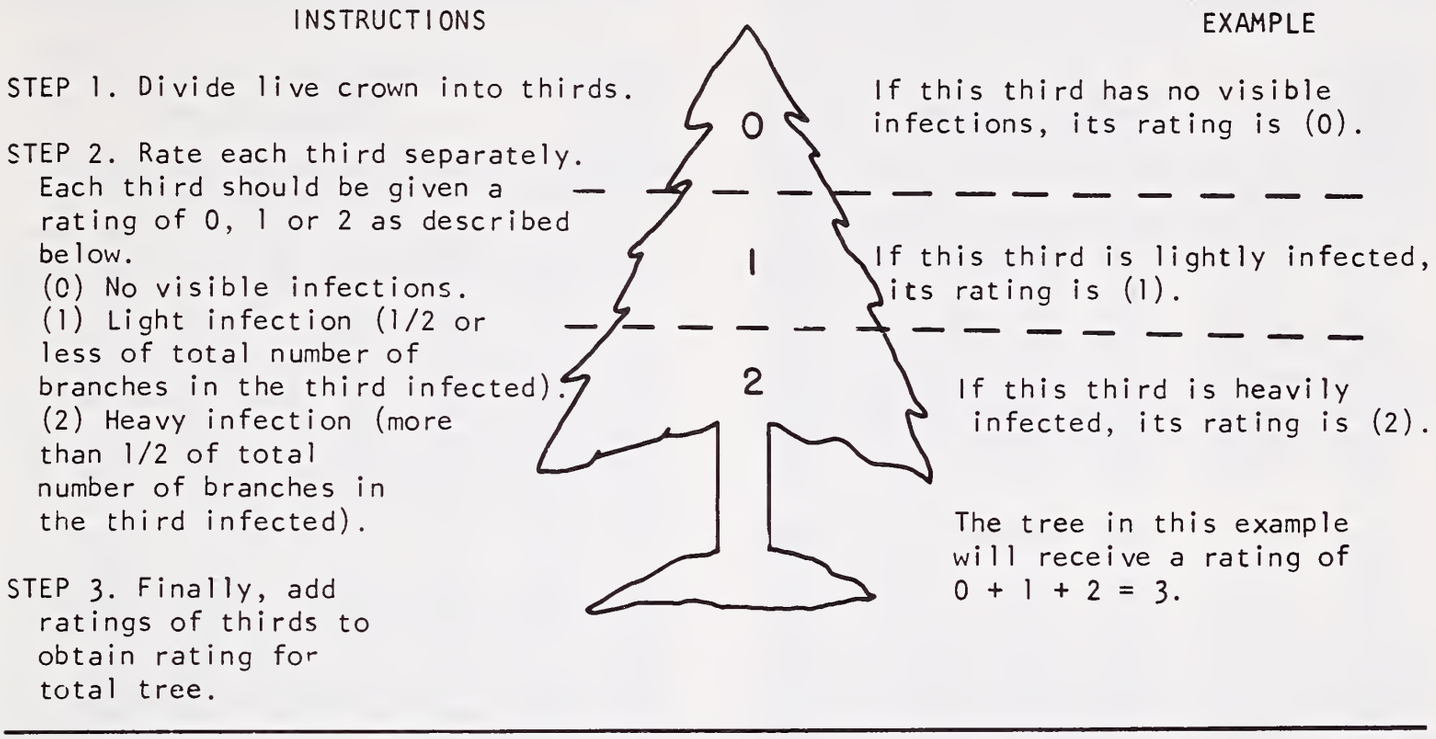

Figure 1.—Instructions for and example of the use of the 6-class mistletoe rating system (Hawksworth 1977).

fected trees in southwestern ponderosa pine and lodgepole pine stands. The value of START is not the age when the earliest infection began, but the mean age when infection began at various points throughout the stand. START is difficult to obtain from field measurements because it requires direct aging of infections, but is useful in studying hypothetical stands for the development of management guidelines.

Control of Stand Density

Growing stock levels are used to specify the stand density to be retained after all partial cuts. Growing stock levels are designated by the square feet of basal area per acre desired when average stand diameter (d.b.h.) is 10 inches or more (Myers 1971). Basal area retained in a stand or story of smaller average d.b.h. is less than the designated level. Desired stand density will vary with objectives of management so that a family of growing stock relationships are needed as shown in table 1 and figure 2. In an even-aged stand, for example, if a growing stock level of 80 is desired, and the stand is expected to have an average d.b.h. after thinning of 5.0 inches, the basal area to be retained is 46.8 square feet per acre. If a growing stock level of 100 is desired, (100/80) × 46.8 or 58.5 square feet per acre will be retained (Hawksworth and Myers 1973). Table 1 can also be used to estimate the appropriate growing stock level if it is desired to leave a certain residual basal area for a given average d.b.h.

Table 1.—Basal areas (square feet) after partial cutting in relation to average diameter (inches) and growing stock level

Average d.b.h. after cutting	Growing stock level						
	40	60	80	100	120	140	160
1.0	3.0	4.5	6.0	7.5	9.0	10.5	12.0
1.5	4.6	6.8	9.1	11.4	13.6	15.9	18.2
2.0	6.0	9.1	12.1	15.1	18.2	21.2	24.2
2.5	9.0	13.4	17.9	22.4	26.8	31.3	35.8
3.0	11.8	17.8	23.7	29.6	35.6	41.5	47.4
3.5	14.8	22.1	29.5	36.9	44.2	51.6	59.0
4.0	17.6	26.4	35.2	44.0	52.8	61.6	70.4
4.5	20.5	30.8	41.0	51.2	61.5	71.8	82.0
5.0	23.4	35.1	46.8	58.5	70.2	81.9	93.6
5.5	25.9	38.8	51.8	64.8	77.7	90.6	103.6
6.0	28.3	42.4	56.6	70.8	84.9	99.0	113.2
6.5	30.6	45.9	61.2	76.5	91.8	107.1	122.4
7.0	32.7	49.0	65.4	81.8	98.1	114.4	130.8
7.5	34.6	51.9	69.2	86.5	103.8	121.1	138.4
8.0	36.2	54.4	72.5	90.6	108.8	126.9	145.0
8.5	37.6	56.5	75.3	94.1	113.0	131.8	150.6
9.0	38.8	58.1	77.5	96.9	116.2	135.6	155.0
9.5	39.6	59.3	79.1	98.9	118.6	138.4	158.2
10.0+	40.0	60.0	80.0	100.0	120.0	140.0	160.0

Table 2 relates the number of residual stems per acre to average d.b.h. after thinning for various growing stock levels. Table 3 relates the average

Table 2.—Number of residual stems per acre in relation to average diameter (inches) and growing stock level

Average d.b.h. after cutting	Growing stock level						
	40	60	80	100	120	140	160
1.0	553	830	1,107	1,383	1,660	1,937	2,213
2.0	277	415	553	692	830	968	1,107
3.0	241	361	482	602	723	843	964
4.0	202	303	404	505	606	707	808
5.0	172	258	343	429	515	601	687
6.0	144	216	288	361	433	505	577
7.0	122	184	245	306	367	428	489
8.0	104	156	208	260	312	364	415
9.0	88	132	175	219	263	307	351
10.0	73	110	147	183	220	257	293
12.0	51	76	102	127	153	178	204
14.0	37	56	75	94	112	131	150
16.0	29	43	57	72	86	100	115
18.0	23	34	45	57	68	79	91
20.0	18	28	37	46	55	64	73
25.0	12	18	23	29	35	41	47
30.0	8	12	16	20	24	29	33

Table 3.—Average distance (feet) between residual trees in relation to average diameter (inches) and growing stock level

Average d.b.h. after cutting	Growing stock level						
	40	60	80	100	120	140	160
1.0	8.9	7.3	6.3	5.6	5.1	4.8	4.4
2.0	12.5	10.2	8.9	7.9	7.2	6.7	6.3
3.0	13.4	11.0	9.5	8.5	7.8	7.2	6.7
4.0	14.7	12.0	10.4	9.3	8.5	7.9	7.3
5.0	15.9	13.0	11.3	10.1	9.2	8.5	8.0
6.0	17.4	14.2	12.3	11.0	10.0	9.3	8.7
7.0	18.9	15.4	13.3	11.9	10.9	10.1	9.4
8.0	20.5	16.7	14.5	13.0	11.8	10.9	10.2
9.0	22.3	18.2	15.8	14.1	12.9	11.9	11.1
10.0	24.4	19.9	17.2	15.4	14.1	13.0	12.2
12.0	29.2	23.9	20.7	18.5	16.9	15.6	14.6
14.0	34.1	27.9	24.1	21.6	19.7	18.2	17.1
16.0	39.0	31.8	27.6	24.7	22.5	20.8	19.5
18.8	43.9	35.8	31.0	27.7	25.3	23.4	21.9
20.0	48.7	39.8	34.5	30.8	28.1	26.1	24.4
25.0	60.9	49.7	43.1	38.5	35.2	32.6	30.5
30.0	73.1	59.7	51.7	46.2	42.2	39.1	36.6

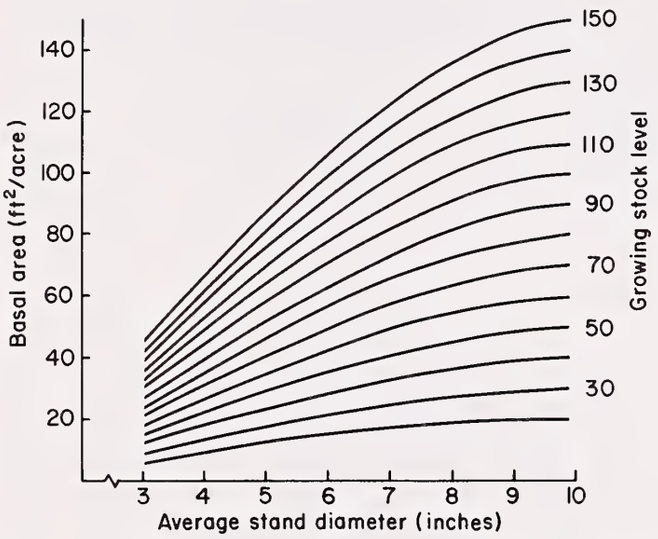

Figure 2.—Basal area after thinning in relation to average stand diameter for standard levels of growing stock (Myers 1971).

spacing between residual trees to average d.b.h. after thinning. Appendix 1 contains a series of tables comparing average d.b.h. before and after partial cutting for various intensities of cutting for the species currently in RMYLD. Growing stock levels for partial cuts in each story of two-storied stands apply only to the basal area and average d.b.h. of the story involved, and not to the combined basal area of both stories.

Sets of three equations for growing stock level (GSLEVL) in subroutines CUTS and PROJ are obtained from the values in table 1. They compute the equivalent growing stock level when basal area and average d.b.h. are known. These relationships were developed from a thinning study of Black Hills ponderosa pine (Myers 1967). They are used in RMYLD for all species because such detailed studies have not been conducted for lodgepole pine or spruce-fir stands. Based on previous experience with programs LPMIST and SPRYLD, the relationships adequately describe the development of young stands of these species as well.

Description of Program RMYLD

Program RMYLD consists of a main program and 10 subroutines, four of which contain species-specific statements. Operations and computations performed by each routine are described below and identified by comments in the source program. Input variables and data deck structure are described in the section on input requirements. Procedures for modifying the program for local use or to include additional species are described in the section on program modification.

Main Program

The main program performs the following operations:

1. Reads program controls from the first data card. These controls specify the number of stands to be processed, character width of the line printer, and units of input and output data.

2. Calls subroutine BEGIN at the beginning of processing of each stand to initialize storage variables, read all data for the stand being processed, store input data for later use, and check data for illegal values. If an illegal value is detected, an error message is printed, and processing of the stand terminates.

3. Enters a series of nested loops for each stand to examine multiple values of the delay period before the initial thinning, growing stock levels for initial and subsequent thinnings, and intervals between intermediate cuts as specified on the data cards read by subroutine BEGIN.

4. Calls subroutine FIRST to initialize variables for each yield table and compute initial values of stand characteristics and yield table controls.

5. Calls subroutines CUTS and PROJ in sequence for as many projection periods required to reach the final age desired for each yield table.

6. Calls subroutine TABLE to print yield tables for the stand. One table is printed for even-aged stands, and separate tables are printed for the overstory and understory of two-storied stands.

Subroutine BEGIN

Subroutine BEGIN is called by the main program to initiate processing of each set of stand data. Variables used to store input data are assigned initial values of zero to clear values from previous stands. Four cards (type 2, 3, 4, and 5) are read by BEGIN to describe the management controls and stand conditions to be used in computations. These control and stand variables are described in the section on input requirements. Input variables are examined for illegal values. An error flag is set if an illegal value is detected. Initial stand ages and variables used to set time intervals and stand ages when operations will occur are rounded off to the nearest 10 years to insure proper program execution. Management controls for the understory are set to overstory values, if the understory controls are left blank on the data cards. If the input data is expressed in metric units, values are converted to U.S. customary units for subsequent computations.

Values of 49 input variables are stored in two arrays to allow initial stand conditions and management controls to be reset if more than one yield table is desired for the stand being processed.

Subroutine FIRST

Subroutine FIRST is called by the main program to initiate computations of each yield table desired for the stand being processed. Many variables are assigned initial values to clear values from computation of previous yield tables. Management controls and initial stand conditions are reset to values of two input storage arrays. By calling the proper species-specific subroutine, FIRST computes the values of several variables that complete the description of initial stand conditions. Where appropriate, separate values are computed for each story of two-storied stands. The final age to appear in the yield table is determined. Initial average DMR, if applicable, and average height of dominant and codominant trees are computed if these values were left blank on data card type 4. Initial basal area and volumes are also computed, and stand conditions are then stored for later recall when the yield tables are printed.

Subroutine CUTS

Subroutine CUTS is called by the main program to execute thinnings and regeneration cuts specified by management controls. CUTS also makes any necessary changes in the interval between cuts and residual density of shelterwoods.

A thinning will be bypassed if any of the following conditions exists at the time the thinning is scheduled:

1. Current growing stock level for the stand or story is already at or below the growing stock goal.

2. Current average DMR, if applicable, exceeds the maximum value specified by the program user.

3. Noncommercial volumes would be cut, and the control variable is given a value to deny this option.

A scheduled regeneration cut will be bypassed if the current growing stock level for the stand or story is at or below the residual growing stock goal.

CUTS contains an iterative algorithm to execute all partial cuts to the desired growing stock level. Various intensities of thinning are examined until the residual number of trees and average tree d.b.h. meet the residual growing stock goal. This new algorithm may produce post-cutting values which are slightly different from the values computed by the earlier programs. These differences will not significantly affect total yields, however. Post-cutting values are computed using equations in the proper species-specific subroutine. These values include average d.b.h., average height, number of trees, basal area, volumes, and average DMR, if applicable. These values and values of number of trees, basal area, average d.b.h., and volumes removed are stored for later printing in the yield tables.

In two-storied stands, CUTS executes thinnings and regeneration cuts separately for each story. A cutting in only one story or simultaneous cuttings in both stories may be scheduled. The user may specify that a cutting in the overstory will destroy a percentage of the trees in the understory based on the amount of basal area removed. This loss may be reduced by the user for subsequent cuts in the overstory. Growing stock level specified for a cut applies only to the basal area and average d.b.h. of the story involved, and not to the combined basal area of both stories.

Subroutine PROJ

Subroutine PROJ is called by the main program to compute stand growth, mortality, and other changes during 10-year projection periods. The routine processes the values of each story of two-storied stands separately.

By calling the proper species-specific subroutine, PROJ computes the following values for each projection period: (1) average DMR at the end of period, if applicable, (2) actual growing stock level, (3) average d.b.h. and height at the end of the period, (4) mortality during the period, and (5) basal area and volumes at the end of the period. PROJ uses the combined basal area of both stories in calculations of growing stock level for each story, growth projections, and mortality. Values at the end of the period are stored for later printing in the yield tables.

Subroutine TABLE

Subroutine TABLE is called by the main program after all computations for the yield table are completed. Separate tables are printed for the overstory and understory of two-storied stands. If the output data is to be expressed in metric units, TABLE performs the necessary conversions from U.S. customary units. TABLE contains format statements to print yield tables on line printers with 80 or 132 character width, as specified by the user. A series of footnotes is printed at the end of each yield table to report the following: (1) merchantability limits for cubic foot and board foot volumes, (2) minimum volumes included in total yields, (3) type of initial thinning allowed, (4) minimum average DMR that prevents intermediate cuts, if applicable, (5) initial status of dwarf mistletoe infestation if average DMR is not reported, (6) controls on noncommercial thinnings, (7) skipping of scheduled intermediate cuts, and (8) expected losses in the understory when cuts are made in the overstory of two-storied stands. Examples of the tables are given in Appendix 2.

Subroutine SPP

Subroutine SPP is included as a switching link between subroutines FIRST, CUTS, and PROJ and the proper species-specific subroutine. The species number, IDSPP, is read from data card type 2. The value of an index variable, ICOMP, is transferred to the species-specific subroutines to insure the desired computations will be performed.

Species-Specific Subroutines

The current version of RMYLD contains four species-specific subroutines: (1) BHPOND for ponderosa pine stands in the Black Hills, (2) LODGPP for lodgepole pine stands in Colorado and southern Wyoming, (3) SWPOND for ponderosa pine stands in Arizona and New Mexico, and (4) SPRFIR for Engelmann spruce-subalpine fir stands in the central and southern Rocky Mountains. Relationships used in RMYLD have been adapted from

programs PONYLD (Myers 1971), LPMIST (Myers et al. 1971), SWYLD2 (Myers et al. 1976), SPRYLD (Alexander et al. 1975) and TEVAP2 (Myers 1974).

Relationships and equations contained in the 14 sections of each species-specific subroutine are listed in order below. A computation index selects the appropriate section. Inapplicable sections are bypassed. Examples of this include all sections dealing with dwarf mistletoe infestation in subroutines BHPOND and SPRFIR and the section which computes average d.b.h. after partial cutting from above in SPRFIR.

The sections perform the following computations:

1. Initial average DMR from percentage of trees infected (PINF) or average age when mistletoe infection began (START). This section is called by subroutine FIRST. The call is bypassed if DMR is read from card type 4.

2. Initial average dominant and codominant height (HTSO) if value is not entered on data card type 4. An additional equation for HTPCT computes any reduction due to dwarf mistletoe during the period from stand origin to first entry in the yield table. This section is called by FIRST.

3. Average d.b.h. after partial cutting from above (DBHE) as used by subroutine CUTS.

4. Average d.b.h. after partial cutting from below (DBHE) as used by CUTS.

5. Change in average dwarf mistletoe rating (DELDMR), due to partial cutting from above or below, as used by CUTS.

6. Percentage of trees infected with dwarf mistletoe (PINF) before a partial cut, for subroutine CUTS.

7. New average DMR at the end of each growth projection period, for subroutine PROJ. This section contains three sets of computations: (1) non-zero DMR that accounts for latent infestation after apparent elimination of the parasite by partial cutting; (2) initial DMR if infestation occurs after the initial age in the yield table, and (3) DMR if an infestation exists and neither of the previous situations apply.

8. New average d.b.h. (DBHO) at the end of each growth projection period. More than one equation may be necessary to estimate growth over a wide range of stand densities. This computation includes the effect of dwarf mistletoe infestation (DINC), if applicable. This section is called by PROJ.

9. Periodic mortality (OUT) for each projection period, as used by subroutine PROJ. Additional equations for DIE are included for dwarf mistletoe infested stands, if applicable.

10. New average dominant and codominant height (HTSO) at the end of each growth projection period, for subroutine PROJ. More than one set of equations may be needed to estimate growth over a wide range of stand densities. This computation includes the effect of dwarf mistletoe infestation (PCT), if applicable.

11. Stand volumes present at the initial age in the yield table, at the end of each growth projection period, and after each partial cut. This section is called by FIRST, PROJ, and CUTS. Total cubic volume per acre (TCF) of all trees is computed with stand volume equations. Factors are then computed and used to convert total cubic volume to merchantable cubic feet (FCTR) and board feet (PROD).

12. Change in average dominant and codominant height (ADDHT) due to partial cutting from below and from above, if applicable. This section is called by CUTS.

13. Merchantable cubic feet obtained as a by-product of a sawlog cut (SCFM) for subroutine CUTS.

14. Set upper limits for average d.b.h. (DBHMAX) and average dominant and codominant height (HTMAX) for subroutine FIRST. Also the number of projection periods (TEMDM) that a stand will exist after the average DMR reaches 6 is set.

Input Requirements

Values of 60 variables that describe stand conditions or control program execution are read from data cards supplied by the program user. Names and definitions of these variables are given in the tabulation headed Order and Contents of the Data Deck. With the exception of IDSTND on card type 2, all data must be right-justified in the appropriate fields. Variables having I, J, M, or N as the first letter in their names have integer or alphanumeric values. All other variables have real (floating point) values.

The data deck for RMYLD consists of five different card types. Card type 1 appears at the beginning of the data deck. Only one card type 1 is read during a single computer run. Sets of card types 2, 3, 4, and 5 must appear for each different stand condition or set of regeneration cut controls to be studied.

Values of variables associated with the understory of two-storied stands on card types 3, 4, and 5 should be left blank if the stand being studied is even-aged. Only the stand and overstory values are used for even-aged stands. RMYLD will process single-or two-storied stands of ponderosa pine and Engelmann spruce-subalpine fir while lodgepole pine stands must be even-aged. RMYLD will ignore any understory input data for lodgepole pine.

As mentioned earlier, only one of the three alternative ways of reporting the level of a dwarf mistletoe infestation should be used for lodgepole pine and southwestern ponderosa pine stands. The values for the remaining two variables should be set to zero or left blank. Different alternatives may be used for each story in a two-storied stand. For example, average DMR might be used for an infested overstory and PINF for the understory.

The alternative of no management can be simulated by not performing any thinnings during the life of the stand. To suppress thinnings, the value of DELAY on card type 3 should be set to the difference between the removal age for clearcutting, smallest REGN on card type 5, and initial stand or story age, AGEO on card type 4. To insure proper program execution, the values of all variables for stand ages and time intervals should be rounded off to the nearest multiple of ten years. Subroutine BEGIN will perform this rounding if needed.

The program user may specify that a series of delay periods between the initial age in the yield table and the first cut (DELAY), growing stock levels for initial and subsequent intermediate cuts (THIN and DSTY), and intervals between intermediate cuts (JCYCL) be examined for each set of stand data. A separate yield table will be computed and printed for each desired combination of DELAY, THIN, DSTY, and JCYCL. The number of yield tables produced for a single stand is the product of the values of INCDEL, INCTHN, INCDST, and INCJCY on card type 3.

The values for initial stand conditions on card type 4 may be obtained in one of two ways, depending on the purpose of the yield tables produced. If the purpose is to estimate performance of a hypothetical managed stand, numerous young stands should be examined to determine tree size and density goals at various ages for each site class. The objective is to establish standards if regeneration and subsequent growth and mortality progress to some set goal for each site class. When the purpose is to estimate future performance of an actual stand, usual stand inventory procedures can be used to provide needed values of stand variables.

Variable IHRVST on card type 5 allows the user to simulate prescribed partial cutting practices in old-growth lodgepole pine stands (Alexander 1975) and Engelmann spruce-subalpine fir stands (Alexander 1973). If a shelterwood system is being used and IHRVST is assigned a value one, the stocking level retained after the first regeneration cut will be a percentage (VLLV) of the basal area present before the cut. For example, the recommended cutting treatment for a single-storied stand of lodgepole pine in a low windfall risk situation is to remove 30% of the basal area with the first cut, another 30% of the original basal area with the second cut, and the remaining basal area with the third cut. The user may simulate this treatment by assigning VLLV (1,1) a value of 0.7 and VLLV (1,2) a value of 0.57. With these specifications, 70% of the basal area would be retained after the first regeneration cut, and 40% ($0.7 \times 0.57 = 0.4$) of the original basal area would be retained after the second cut.

Order and Contents of the Data Deck

Card type	Number of cards	Variable name	Columns	Format	Description of variable
1	1	NSTAND	1-5	I5	Number of sets of stand records to be processed in a single computer run. This is the number of sets of card types 2, 3, 4, 5 to follow in the data deck. Default value is one.
		ICARR	6-10	I5	Character width of line printer being used. Must have a value of either 80 or 132. Default value is 80.

Card type	Number of cards	Variable name	Columns	Format	Description of variable
		MIN	11-15	I5	Control variable to specify the units of input variables. MIN is assigned a value of zero (0) for U.S. customary units, and a value of one (1) for international metric units. Default value is zero.
		MOUT	16-20	I5	Control variable to specify the units of output variables. MOUT is assigned a value of zero (0) for U.S. customary units, and a value of one (1) for international metric units. Default value is zero.
2	1 per stand	IDSPP	1-5	I5	Control variable with value defined below to identify tree species. 1 - Black Hills ponderosa pine 2 - Lodgepole pine 3 - Southwestern ponderosa pine 4 - Engelmann spruce-subalpine fir
		COMCU	6-10	F5.0	Minimum cut in merchantable cubic feet per acre (cubic meters per hectare) to be included in total yields. The value of COMCU is also used to determine if a thinning meets commercial limits, if any are imposed. See variable ICUT. If commercial limits are imposed, scheduled thinnings will be performed if either COMCU or COMBF is met. If only one volume measurement is to be used for control, the other should be set very high.
		COMBF	11-15	F5.0	Minimum cut in board feet per acre to be included in total yields. The value of COMBF is also used to determine if a thinning meets commercial limits, if any are imposed. See variable ICUT. The value of COMBF will be ignored if MIN has a value of one.
		ICUT(1)	16-20	I5	Control variable to determine the number of noncommercial thinnings in the overstory that will be executed. A value of zero (0) causes all non-commercial thinnings to be bypassed. A value of one (1) allows only the initial thinning in the stand or a story to be noncommercial. Subsequent noncommercial thinnings will be bypassed. A value of two (2) allows all acheduled thinnings to be noncommercial. The values of COMCU and COMBF specify the minimum commercial limits.
		ICUT(2)	21-25	I5	Control variable to determine the number of noncommercial thinnings in the understory that will be executed. The discussion of ICUT(1) also applies to ICUT(2).
		DMLEV	26-30	F5.1	Dwarf mistletoe rating above which thinnings will not be performed. Experience in lodgepole pine and ponderosa pine stands indicates that thinnings can not materially reduce effects of the infestation or improve stand growth when DMR exceeds 3.0 (Myers et al. 1976). Regeneration cuts will be performed when they are scheduled even if DMR exceeds DMLEV. Leave DMLEV blank for Black Hills ponderosa pine and Engelmann spruce-subalpine fir stands.
		IDSTND	31-80	10A5	Stand identification and description of test conditions. May be up to 50 characters long including blanks.

The user should leave the values for all understory variables blank on card types 3, 4, 5 for lodgepole pine stands.

3	1 per stand	DELAY (1)	1-5	F5.0	Number of years between initial age in yield table and first cut in the overstory. The value of DELAY(1) must be a multiple of 10. DELAY(1) will have a value of zero if a cutting is desired at the initial age of the overstory in the yield table (AGEO(1), card type 4).
		INCDEL	6-10	I5	Number of delay periods to be examined for a single stand. DELAY(1) and DELAY(2), if applicable, will be increased by 10 years for each subsequent set of yield tables if INCDEL has a value greater than one. Default value is one.

Card type	Number of cards	Variable name	Columns	Format	Description of variable
		IOPT(1)	11-15	I5	Control to specify whether the initial thinning in a dwarf mistletoe infested overstory will be from above or below. Thinning from above emphasizes, but is not restricted, to removal of the larger trees. Such cutting is usual practice in infested stands because the larger trees usually support the greater amounts of dwarf mistletoe. IOPT(1) should be assigned a value of zero (0) if initial thinning is to be from above, and a value of one (1) if the initial thinning is to be from below. Leave IOPT(1) blank for Black Hills ponderosa pine and Engelmann spruce-subalpine fir stands.
		THIN(1)	16-20	F5.0	Growing stock level for initial thinning in the overstory. In U.S. customary units values for THIN(1) will frequently be 80 to 120, but may range from 40 to 160. In dwarf mistletoe infested stands when thinning from above with THIN(1) assigned a value greater than 60, RMYLD reduces the value of THIN(1) to simulate additional removals for control purposes. The amount of reduction is based on the initial DMR and is given by the formula (DMR/3.0) × (THIN-60.0). If the initial DMR is greater than 3.0, then RMYLD assigns THIN(1) a value of 60 unless a lower input value is specified.
		INCTHN	21-25	I5	Number of growing stock levels for initial thinning to be examined for a single stand. THIN(1) and THIN(2), if applicable, will be increased by THNADD for each subsequent set of yield tables if INCTHN has a value greater than one. Default value is one.
		THNADD	26-30	F5.0	Amount THIN(1) and THIN(2), if applicable, will be increased on subsequent sets of yield tables if INCTHN has a value greater than one.
		DSTY(1)	31-35	F5.0	Growing stock level for intermediate cuts after the first in the overstory. Value for DSTY(1) may be the same as the value for THIN(1). In U.S. customary units, values for DSTY(1) will also frequently be 80 to 120, but may range from 40 to 160.
		INCDST	36-40	I5	Number of growing stock levels for intermediate cuts after the first to be examined for a single stand. DSTY(1) and DSTY(2), if applicable, will be increased by DSTADD for each subsequent set of yield tables if INCDST has a value greater than one. Default value is one.
		DSTADD	41-45	F5.0	Amount DSTY(1) and DSTY(2), if applicable, will be increased on subsequent sets of yield tables if INCDST has a value greater than one.
		JCYCL(1)	46-50	I5	Interval, in years, between intermediate cuts in the overstory. The value of JCYCL(1) must be a multiple of 10.
		INCJCY	51-55	I5	Number of intervals between intermediate cuts to be examined for a single stand. JCYCL(1) and JCYCL(2), if applicable, will be increased by ten years for each subsequent set of yield tables if INCJCY has a value greater than one. Default value is one.
		DELAY(2)	56-60	F5.0	Number of years between initial age in yield table and first cut in the understory. The discussion of DELAY(1) also applies to DELAY(2).
		IOPT(2)	61-65	I5	Control to specify whether the initial thinning in an infested understory will be from above or below. The discussion of IOPT(1) also applies to IOPT(2).
		THIN(2)	66-70	F5.0	Growing stock level for initial thinning in the understory. The discussion of THIN(1) also applies to THIN(2).
		DSTY(2)	71-75	F5.0	Growing stock level for intermediate cuts after the first in the understory. The discussion of DSTY(1) also applies to DSTY(2).

Card type	Number of cards	Variable name	Columns	Format	Description of variable
		JCYCL(2)	76-80	I5	Interval in years between intermediate cuts in the understory. The discussion of JCYCL(1) also applies to JCYCL(2).
4	1 per stand	SITE	1-5	F5.0	Site index of the stand based on mean height of overstory dominant trees for lodgepole pine and spruce-fir stands and dominant and codominant trees for ponderosa pine stands at a base age of 100 years. Total tree age is used for all species except spruce-fir which uses breast height age. The value of SITE must be a reliable indicator of relative productivity. Trees in dense stands or with any disease or deformity that may reduce height growth do not furnish reliable information. In such cases, site index can be estimated from suitable nearby stands or from soil variables. Applicable site curves may be found in the following references: (1) ponderosa pine (Meyer 1938); (2) lodgepole pine (Alexander 1966); (3) Engelmann spruce (Alexander 1967).
		AGEO(1)	6-10	F5.0	Mean age in years of live overstory dominant and codominant trees at the first entry in the yield table. Total tree age is used for all species except spruce-fir which uses breast height age. AGEO(1) should be rounded off to the nearest multiple of 10 years.
		DBHO(1)	11-15	F5.1	Mean diameter breast height of all live overstory trees at age AGEO(1), regardless of crown class or species. The value of DBHO(1) should be determined to the nearest 0.1 inch (centimeter). Average d.b.h. is the diameter of the tree of average basal area.
		HTSO(1)	16-20	F5.1	Mean height in feet (meters) of live overstory dominant and codominant trees at age AGEO(1). The value of HTSO(1) may be left blank when examining hypothetical stands with a density below growing stock level 160. For actual stands, the value of HTSO(1) should be determined from field measurements to account for the past effects of stand density and disease on height growth.
		DENO(1)	21-25	F5.0	Number of all live overstory trees per acre (hectare) at age AGEO(1), regardless of crown class or species. Only trees taller than breast height should be counted.
		DMR(1)	26-30	F5.1	Average dwarf mistletoe rating of all live overstory trees at age AGEO(1). Leave DMR(1) blank for Black Hills ponderosa pine and Engelmann spruce-subalpine fir stands.
		PINF(1)	31-35	F5.1	Percentage of the live overstory trees infected with dwarf mistletoe at age AGEO(1). Leave PINF(1) blank for Black Hills ponderosa pine and Engelmann spruce-subalpine fir stands.
		START(1)	36-40	F5.0	Age of the overstory trees, in years, when the dwarf mistletoe infection began or is expected to begin in the overstory at various points throughout the stand. For an uninfested overstory in lodgepole pine or southwestern ponderosa pine stands, the value of START(1) must be greater than the largest overstory REGN (card type 5). Leave START(1) blank for Black Hills ponderosa pine and Engelmann spruce-subalpine fir stands.
		AGEO(2)	41-45	F5.0	Mean age, in years, of live potential dominant and codominant trees in the understory at the first entry in the yield table. The discussion of AGEO(1) also applies to AGEO(2).
		DBHO(2)	46-50	F5.1	Mean d.b.h. of all live understory trees at age AGEO(2), regardless of crown class or species. The discussion of DBHO(1) also applies to DBHO(2).
		HTSO(2)	51-55	F5.1	Mean height in feet (meters) of live potential dominant and codominant trees in the understory at age AGEO(2). The discussion of HTSO(1) also applies to HTSO(2).
		DENO(2)	56-60	F5.0	Number of all live understory trees per acre (hectare) at age AGEO(2). Only trees taller than breast height should be counted.

Card type	Number of cards	Variable name	Columns	Format	Description of variable
		DMR(2)	61-65	F5.1	Average dwarf mistletoe rating of all live understory trees at age AGEO(2). Leave DMR(2) blank for Black Hills ponderosa pine and Engelmann spruce-subalpine fir stands.
		PINF(2)	66-70	F5.1	Percentage of the live understory trees infected with dwarf mistletoe at age AGEO(2). Leave PINF(2) blank for Black Hills ponderosa pine and Engelmann spruce-subalpine fir stands.
		START(2)	71-75	F5.0	Age of the understory trees in years when the dwarf mistletoe infection began or is expected to begin in the understory at various points throughout the stand. The discussion of START(1) also applies to START(2).
			76-80	A5	The user may punch an identifying code for the stand in these columns. The code is ignored by RMYLD.
5	1 per stand	IDELR(1)	1	I1	Control assigned a value of one (1) if stand ages for regeneration cuts in the overstory are to be increased by current value of DELAY(1) (card type 3). Assign a value of zero (0) otherwise.
		REGN(1,1)	2-5	F4.0	Age in years when the first regeneration cut will occur in the overstory. REGN(1,1) should be a multiple of 10 and must never be zero or blank. The value of REGN(1,1) is the age for clearcutting if the following four variables are left blank.
		VLLV(1,1)	6-10	F5.3	Percentage, as a decimal, of growing stock level for previous intermediate cuts, DSTY(1) (card type 3), or overstory basal area before the cut to be retained at age REGN(1,1). See variable IHRVST(1). Leave this and the next five variables blank if a clearcut system is being used.
		REGN(1,2)	11-15	F5.0	Age in years when the second regeneration cut, if any, will occur in the overstory. This is the age when the final cut of a two-cut shelterwood or the second cut of a three-cut shelterwood will occur. The value of REGN(1,2) should be equal to the value of REGN(1,1) plus a nonzero multiple of 10 years.
		VLLV(1,2)	16-20	F5.3	Percentage, as a decimal, of growing stock level retained after the first regeneration cut in the overstory to be retained at age REGN(1,2). Leave this and the next variable blank if a two-cut shelterwood system is being used.
		REGN(1,3)	21-25	F5.0	Age in years when the third regeneration cut, if any, will occur in the overstory. This is the age when the final cut of a three-cut shelterwood will occur. The value of REGN(1,3) should be equal to the value of REGN(1,2) plus a nonzero multiple of 10 years.
		IHRVST(1)	26-30	I5	Control to specify the basis of the growing stock level to be retained in the overstory at age REGN(1,1) if a shelterwood system is used. IHRVST(1) is assigned a value of zero (0) if VLLV(1,1) is a percentage of the growing stock level for previous intermediate cuts, DSTY(1) (card type 3). IHRVST(1) is assigned a value of one (1) if VLLV(1,1) is a percentage of the overstory basal area immediately before the cut.
		IABOVE(1)	31-35	I5	Control to specify whether shelterwood cuts in the overstory will be from above or below. IABOVE(1) is assigned a value of zero (0) if cutting is from below, and a value of one (1) if cutting is from above. Leave IABOVE(1) blank for Engelmann spruce-subalpine fir stands.
		USLOSS	36-40	F5.3	Percentage, as a decimal, of the existing understory trees which will be destroyed when 100 square feet of basal area per acre (23 square meters per hectare) is cut from the overstory. RMYLD assumes that percent damage follows a linear function between 0 and 100 square feet of basal area removed. Leave USLOSS blank if no logging damage to the understory is expected.

Card type	Number of cards	Variable name	Columns	Format	Description of variable
		PCTLOS	41-45	F5.3	Cumulative percentage reduction, as a decimal, of USLOSS for each overstory cut after the first.
		IDELR(2)	46	I1	Control assigned a value of one (1) if stand ages for regeneration cuts in the understory are to be increased by current value of DELAY(2) (card type 3). Assign a value of zero (0) otherwise.
		REGN(2,1)	47-50	F4.0	Age, in years, when the first regeneration cut will occur in the understory. If REGN(2,1) is left blank, RMYLD will assign the values of REGN(1,1), VLLV(1,1), REGN(1,2), VLLV(1,2), REGN(1,3), IHRVST(1), and IABOVE(1) to the corresponding understory variables. With this exception the discussion of REGN(1,1) also applies to REGN(2,1).
		VLLV(2,1)	51-55	F5.3	Percentage, as a decimal, of growing stock level for previous intermediate cuts, DSTY(2) (card type 3), or understory basal area before the cut to be retained at age REGN(2,1). See variable IHRVST(2). Leave this and the next five variables blank if a clearcut system is being used.
		REGN(2,2)	56-60	F5.0	Age in years when the second regeneration cut, if any, will occur in the understory. This is the age when the final cut of a two-cut shelterwood will occur. The value of REGN(2,2) should be equal to the value of REGN(2,1) plus a nonzero multiple of 10 years.
		VLLV(2,2)	61-65	F5.3	Percentage, as a decimal, of growing stock level retained after the first regeneration cut in the understory to be retained at age REGN(2,2). Leave this and the next variable blank if a two-cut shelterwood system is being used.
		REGN(2,3)	66-70	F5.0	Age in years when the third regeneration cut, if any, will occur in the understory. This is the age when the final cut of three-cut shelterwood will occur. The value of REGN(2,3) should be equal to the value of REGN(2,2) plus a nonzero multiple of 10 years.
		IHRVST(2)	71-75	I5	Control to specify the basis of the growing stock level to be retained in the understory at age REGN(2,1) if a shelterwood system is used. IHRVST(2) is assigned a value of zero (0) if VLLV(2,1) is a percentage of the growing stock level for previous intermediate cuts DSTY(2) (card type 3). IHRVST(2) is assigned a value of one (1) if VLLV(2,1) is a percentage of the understory basal area immediately before the cut.
		IABOVE(2)	76-80	I5	Control to specify whether shelterwood cuts in the overstory will be from above or below. The discussion of IABOVE(1) also applies to IABOVE(2).

Program Modification

Readers who will not be modifying the program need not read this section.

RMYLD is written in a modular structure to allow local modifications and addition of relationships for other species. Procedures for determining needed relationships may be found in standard mensuration texts and are discussed in detail elsewhere (Myers 1971, Myers et al. 1976). The source program is well documented by comments to assist the user in following program logic.

Minor local modifications for the species already in RMYLD usually will only require changes in appropriate sections of the proper species-specific subroutine. For example, if stand volumes for southwestern ponderosa pine are to be based on utilization standards other than those printed in the yield table footnotes, then sections 11 and 13 of subroutine SWPOND must be modified. New equations for factors to convert total cubic volume to merchantable cubic feet (FCTR) and board feet (PROD) should replace those in section 11. Also, a new equation for merchantable cubic feet pro-

duced as a byproduct of a sawlog cut (SCFM) should be placed in section 13.

Statements related to stocking may be replaced if a method of expressing growing stock levels other than shown in table 1 and figure 2 is desired. New equations to express GSLEVL as a function of average d.b.h. and basal area per acre must be developed. These new equations should replace the two sets of equations for GSLEVL in subroutine CUTS and the one set of equations for GSLEVL in PROJ.

Relationships for other species or host-dwarf mistletoe combinations can be included by adding another species-specific subroutine. New relationships must be derived for the applicable sections of the species-specific subroutines discussed earlier. If the new subroutine is for healthy stands, subroutines BHPOND and SPRFIR may be used as guides. If the new subroutine will include host-dwarf mistletoe relationships, the structure of LODGPP and SWPOND should be followed. The computed GO TO statement in subroutine SPP should be lengthened to branch to an additional CALL statement for the new subroutine. Minor changes must also be made in subroutine BEGIN to allow the species flag (IDSPP) to have a value greater than four and to skip the DO loop which prevents dwarf mistletoe infestation if the new subroutine includes the effect of the parasite. The first computed GO TO statement in subroutine TABLE must be modified to branch to a new WRITE statement to print the appropriate species heading. New WRITE statements must also be added and proper computed GO TO statements modified to print utilization standards in the table footnotes.

A Sample Problem

The following problem demonstrates many of the computations made by RMYLD and the printed tables produced. It consists of stand conditions and management controls of examples from the test problems of the previously published yield table programs. The data deck for this problem also serves as a test case for use in adapting the source program to locally available computing facilities. Yield tables produced by RMYLD for the sample problem are reproduced in Appendix 2.

The first four yield tables in Appendix 2 are examples of ways RMYLD can be used by the forest manager to determine intensities of thinning that will meet management goals. The first two tables are computed for the same hypothetical stand of ponderosa pine in the Black Hills. The second two tables are for a hypothetical lodgepole pine stand. Intermediate cuttings in each stand are to begin at age 30, when the ponderosa pine stand is expected to have 950 trees per acre with an average d.b.h. of 4.8 inches on areas of site index 70. At age 30, the lodgepole pine stand is expected to have 1,000 trees per acre with an average d.b.h. of 4.5 inches on areas of site index 70, and the stand is free of dwarf mistletoe. The initial thinning reduces stand density to growing stock level 80 in the ponderosa pine stand and to level 120 in the lodgepole pine stand.

Two levels for subsequent intermediate cuts are examined for each stand: (1) levels 80 and 120 for ponderosa pine, and (2) levels 80 and 100 for lodgepole pine. The interval between intermediate cuts is 20 years. Regeneration for the ponderosa pine stand is by two-cut shelterwood with a removal cut at age 110 and the final cut at age 130. Regeneration for lodgepole pine is by small clearcuts at stand age 130.

The next four yield tables in Appendix 2 are computed for a two-storied stand of southwestern ponderosa pine infested with dwarf mistletoe. These tables are produced to examine yield if the overstory is removed and the understory thinned now, compared to the effect on yield if overstory removal and understory treatment is delayed 20 years. Initial thinning in the understory reduces density to growing stock level 120. Subsequent intermediate cuts are to level 90, and the interval between cuts is 20 years. Regeneration is by two-cut shelterwood with a removal cut at age 110 and the final cut at age 130.

The final two yield tables in Appendix 2 are computed for a hypothetical stand of Engelmann spruce and subalpine fir. At breast height age 30, the stand is expected to have 850 stems per acre with an average d.b.h. of 4.5 inches on an area of site index 80. The initial thinning reduces stand density to growing stock level 120. Levels 80 and 120 for subsequent intermediate cuts are examined. The interval between intermediate cuts is 30 years. Regeneration is by two-cut shelterwood with a removal cut at stand age 120 and the final cut at age 150.

The data deck for the sample problem consists of 21 cards shown in figure 3.

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                                                Column Numbers
                         1         2         3         4         5         6         7         8
Card Type  12345678901234567890123456789012345678901234567890123456789012345678901234567890

    1          5  132
    2          1  320  1500    2              SAMPLE OUTPUT, RES. PAP. RM-79, P.19.
    3                          80                   80     2    40    20
    4         70   30    48          950
    5        110  500   130

    2          2  320  1500    2           30 SAMPLE OUTPUT, RES. PAP. RM-72, P.12+13.
    3                         120                   80     2    20    20
    4         70   30    45         1000                 99999
    5        130

    2          3  320  1500    1      1    30 SAMPLE OUTPUT, RES. PAP. RM-163, P.24. NO DELAY
    3                         120                   90                20                    120    90    20
    4         70  150   161   750     20    48                30    41   210   600    10
    5        150                                                    110   500   130

    2          3  320  1500    1      1    30 SAMPLE OUTPUT,RES.PAP.RM-163,P.25. 20-YR DELAY
    3         20               120                   90                20          20        120    90    20
    4         70  150   161   750     20    48                30    41   210   600    10
    5        170                                                    110   500   130

    2          4  400  2000    2              SAMPLE OUTPUT, RES. PAP. RM-134, P.16.
    3                         120                   80     2    40    30
    4         80   30    45          850
    5        120  800   150
```

Figure 3.—Data deck for sample problem.

Yield tables can be used in many ways by forest managers to aid in decisionmaking. Possible long-range management goals can be determined, and feasibility of cultural practices to meet these goals may be examined. Yields, number of noncommercial cuts, number of scheduled cuts that can not be made, and size of the average tree are some of the values produced. Rates of return and money yields can be computed from operational costs and stumpage values.

Comparison of yields from healthy and diseased stands assists the forest manager in quantifying the impact of a disease as important as dwarf mistletoe. A series of alternative management controls may be examined for actual infested stands to determine the expected feasibility of various cultural treatments before large-scale field operations are begun.

Planned Verification

Verification of long-term growth and yield models require an independent sample of periodic growth measurements from a wide variety of stand conditions. Studies are being established in southwestern ponderosa pine and lodgepole pine stands to partially meet these needs.[2] At Fort Valley Experimental Forest, Arizona, 24 permanent plots have been established in pole-size ponderosa pine stands thinned to growing stock levels 60, 80, and 100. Dwarf mistletoe infestation ranges from none to moderate. A similar study is planned for lodgepole pine stands at Fraser Experimental Forest, Colorado, except that growing stock levels 80, 100, and 120 will be examined. Another study to monitor stand development in pole-size lodgepole pine unthinned and thinned to 10- by 10-foot spacing has been established at North Park, Colorado. Stand growth from these studies will be compared to changes predicted by RMYLD, and the program will be modified if necessary.

[2]*Hawksworth, F. G., Rocky Mountain Forest and Range Experiment Station, September 29, 1977, personal communication.*

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Appendix 1

Tables of Average Stand D.B.H. After Partial Cutting

Table A-1—Average diameters (inches) after partial cutting from above to various levels in ponderosa pine stands[1]

Average D.B.H. Before Cutting (Inches)	Percentage of Trees Retained								
	10	20	30	40	50	60	70	80	90
1.0	.3	.4	.5	.6	.7	.8	.8	.9	.9
2.0	.8	1.0	1.2	1.4	1.5	1.6	1.7	1.8	1.9
3.0	1.3	1.7	2.0	2.2	2.3	2.5	2.6	2.8	2.9
4.0	2.0	2.4	2.7	3.0	3.0	3.1	3.3	3.5	3.8
5.0	2.6	3.2	3.6	3.9	4.0	4.1	4.3	4.5	4.7
6.0	3.4	4.0	4.4	4.7	5.0	5.1	5.3	5.5	5.7
7.0	4.2	4.8	5.3	5.7	6.0	6.1	6.2	6.5	6.7
8.0	5.0	5.7	6.2	6.6	7.0	7.1	7.2	7.4	7.7
9.0	5.8	6.6	7.1	7.5	8.0	8.1	8.2	8.4	8.7
10.0	6.7	7.5	8.1	8.5	8.9	9.0	9.2	9.4	9.7
11.0	7.6	8.5	9.0	9.4	9.9	10.0	10.2	10.4	10.7
12.0	8.6	9.4	10.0	10.4	10.9	11.0	11.2	11.4	11.6
13.0	9.5	10.4	11.0	11.4	11.9	12.0	12.2	12.4	12.6
14.0	10.5	11.4	12.0	12.4	12.9	13.0	13.1	13.4	13.6
15.0	11.6	12.5	13.0	13.4	13.9	14.0	14.1	14.3	14.6
16.0	12.6	13.5	14.0	14.4	14.9	15.0	15.1	15.3	15.6
17.0	13.7	14.6	15.1	15.5	15.8	15.9	16.1	16.3	16.6
18.0	14.8	15.6	16.1	16.5	16.8	16.9	17.1	17.3	17.5
19.0	15.9	16.7	17.2	17.6	17.8	17.9	18.1	18.3	18.5
20.0	17.0	17.8	18.3	18.6	18.8	18.9	19.1	19.3	19.5
21.0	18.2	18.9	19.3	19.7	19.8	19.9	20.0	20.2	20.5
22.0	19.4	20.0	20.4	20.7	20.8	20.9	21.0	21.2	21.5
23.0	20.6	21.2	21.5	21.8	21.8	21.9	22.0	22.2	22.5
24.0	21.8	22.3	22.6	22.9	22.7	22.8	23.0	23.2	23.5
25.0	23.0	23.5	23.8	24.0	23.7	23.8	24.0	24.2	24.4

[1]*These values are for healthy stands. In dwarf mistletoe-infested stands, the decrease in average d.b.h. due to thinning will be half the change indicated in the table.*

Table A-2—Average diameters (inches) after partial cutting from below to various levels in ponderosa pine stands[1]

Average D.B.H. Before Cutting (Inches)	Percentage of Trees Retained								
	10	20	30	40	50	60	70	80	90
1.0	1.9	1.6	1.4	1.4	1.3	1.2	1.2	1.2	1.1
2.0	3.3	2.9	2.7	2.6	2.5	2.4	2.3	2.3	2.2
3.0	4.7	4.2	3.9	3.7	3.8	3.7	3.5	3.3	3.1
4.0	6.0	5.4	5.1	4.9	4.8	4.7	4.5	4.4	4.1
5.0	7.2	6.6	6.2	6.0	5.8	5.7	5.6	5.4	5.2
6.0	8.4	7.7	7.3	7.1	6.9	6.7	6.6	6.4	6.2
7.0	9.6	8.9	8.4	8.2	7.9	7.7	7.6	7.4	7.2
8.0	10.8	10.0	9.5	9.2	8.9	8.8	8.6	8.4	8.2
9.0	11.9	11.1	10.6	10.3	9.9	9.8	9.6	9.5	9.2
10.0	13.0	12.1	11.7	11.3	10.9	10.8	10.7	10.5	10.3
11.0	14.1	13.2	12.7	12.4	12.0	11.8	11.7	11.5	11.3
12.0	15.2	14.3	13.7	13.4	13.0	12.8	12.7	12.5	12.3
13.0	16.2	15.3	14.8	14.4	14.0	13.9	13.7	13.5	13.3
14.0	17.3	16.3	15.8	15.4	15.0	14.9	14.7	14.6	14.3
15.0	18.3	17.4	16.8	16.5	16.0	15.9	15.8	15.6	15.4
16.0	19.3	18.4	17.8	17.5	17.1	16.9	16.8	16.6	16.4
17.0	20.3	19.4	18.8	18.5	18.1	18.0	17.8	17.6	17.4
18.0	21.4	20.4	19.8	19.5	19.1	19.0	18.8	18.6	18.4
19.0	22.4	21.4	20.8	20.5	20.1	20.0	19.8	19.7	19.4
20.0	23.3	22.4	21.8	21.4	21.1	21.0	20.9	20.7	20.5
21.0	24.3	23.4	22.8	22.4	22.2	22.0	21.9	21.7	21.5
22.0	25.3	24.3	23.8	23.4	23.2	23.1	22.9	22.7	22.5
23.0	26.3	25.3	24.8	24.4	24.2	24.1	23.9	23.7	23.5
24.0	27.2	26.3	25.7	25.4	25.2	25.1	24.9	24.8	24.5
25.0	28.2	27.2	26.7	26.3	26.2	26.1	26.0	25.8	25.6

[1]*These values are for healthy stands. In dwarf mistletoe-infested stands, the increase in average d.b.h. due to thinning will be half the change indicated in the table.*

Table A-3—Average diameters (inches) after partial cutting from above to various levels in lodgepole pine stands[1]

Average D.B.H. Before Cutting (Inches)	Percentage of Trees Retained								
	10	20	30	40	50	60	70	80	90
1.0	.5	.6	.7	.7	.8	.8	.9	.9	1.0
2.0	1.1	1.3	1.4	1.5	1.6	1.7	1.8	1.9	1.9
3.0	1.7	2.0	2.2	2.4	2.5	2.6	2.7	2.8	2.9
4.0	2.4	2.8	3.1	3.3	3.4	3.4	3.6	3.7	3.9
5.0	3.2	3.6	3.9	4.2	4.3	4.4	4.5	4.7	4.8
6.0	4.0	4.5	4.8	5.1	5.3	5.4	5.5	5.6	5.8
7.0	4.8	5.4	5.7	6.0	6.3	6.3	6.4	6.6	6.8
8.0	5.7	6.3	6.6	6.9	7.2	7.3	7.4	7.6	7.7
9.0	6.5	7.2	7.6	7.9	8.2	8.3	8.4	8.5	8.7
10.0	7.4	8.1	8.5	8.8	9.2	9.2	9.3	9.5	9.7
11.0	8.3	9.0	9.5	9.8	10.1	10.2	10.3	10.5	10.6
12.0	9.3	10.0	10.4	10.7	11.1	11.2	11.3	11.4	11.6
13.0	10.2	10.9	11.4	11.7	12.0	12.1	12.2	12.4	12.6
14.0	11.2	11.9	12.4	12.7	13.0	13.1	13.2	13.3	13.5
15.0	12.2	12.9	13.3	13.7	14.0	14.1	14.2	14.3	14.5
16.0	13.1	13.9	14.3	14.7	14.9	15.0	15.1	15.3	15.5
17.0	14.1	14.9	15.3	15.7	15.9	16.0	16.1	16.2	16.4
18.0	15.2	15.9	16.3	16.7	16.9	17.0	17.1	17.2	17.4
19.0	16.2	16.9	17.4	17.7	17.8	17.9	18.0	18.2	18.3
20.0	17.2	17.9	18.4	18.7	18.8	18.9	19.0	19.1	19.3
21.0	18.3	19.0	19.4	19.7	19.8	19.9	20.0	20.1	20.3
22.0	19.3	20.0	20.4	20.7	20.7	20.8	20.9	21.1	21.2
23.0	20.4	21.1	21.5	21.8	21.7	21.8	21.9	22.0	22.2
24.0	21.5	22.1	22.5	22.8	22.7	22.8	22.9	23.0	23.2
25.0	22.6	23.2	23.6	23.8	23.6	23.7	23.8	24.0	24.1

[1]*These values are for healthy stands. In dwarf mistletoe-infested stands, the decrease in average d.b.h. due to thinning will be half the change indicated in the table.*

Table A-4—Average diameters (inches) after partial cutting from below to various levels in lodgepole pine stands[1]

Average D.B.H. Before Cutting (Inches)	Percentage of Trees Retained								
	10	20	30	40	50	60	70	80	90
1.0	1.6	1.4	1.3	1.2	1.2	1.2	1.1	1.1	1.1
2.0	2.9	2.7	2.5	2.4	2.3	2.3	2.2	2.2	2.1
3.0	4.2	3.9	3.7	3.5	3.5	3.4	3.3	3.2	3.1
4.0	5.5	5.0	4.8	4.7	4.6	4.5	4.4	4.2	4.1
5.0	6.7	6.2	5.9	5.7	5.6	5.5	5.4	5.3	5.1
6.0	7.8	7.3	7.0	6.8	6.6	6.5	6.4	6.3	6.2
7.0	9.0	8.4	8.1	7.9	7.7	7.6	7.5	7.3	7.2
8.0	10.1	9.5	9.2	9.0	8.7	8.6	8.5	8.4	8.2
9.0	11.3	10.6	10.3	10.0	9.7	9.6	9.5	9.4	9.3
10.0	12.4	11.7	11.3	11.1	10.8	10.7	10.6	10.4	10.3
11.0	13.5	12.8	12.4	12.1	11.8	11.7	11.6	11.5	11.3
12.0	14.6	13.9	13.5	13.2	12.8	12.7	12.6	12.5	12.4
13.0	15.6	14.9	14.5	14.2	13.9	13.8	13.7	13.5	13.4
14.0	16.7	16.0	15.6	15.3	14.9	14.8	14.7	14.6	14.4
15.0	17.8	17.0	16.6	16.3	15.9	15.8	15.7	15.6	15.4
16.0	18.8	18.1	17.6	17.3	16.9	16.9	16.8	16.6	16.5
17.0	19.9	19.1	18.7	18.3	18.0	17.9	17.8	17.7	17.5
18.0	20.9	20.1	19.7	19.4	19.0	18.9	18.8	18.7	18.5
19.0	22.0	21.2	20.7	20.4	20.0	20.0	19.8	19.7	19.6
20.0	23.0	22.2	21.7	21.4	21.1	21.0	20.9	20.8	20.6
21.0	24.0	23.2	22.7	22.4	22.1	22.0	21.9	21.8	21.6
22.0	25.0	24.2	23.7	23.4	23.1	23.0	22.9	22.8	22.7
23.0	26.0	25.2	24.8	24.4	24.2	24.1	24.0	23.8	23.7
24.0	26.0	26.0	25.8	25.4	25.2	25.1	25.0	24.9	24.7
25.0	26.0	26.0	26.0	26.0	26.0	26.0	26.0	25.9	25.8

[1]*These values are for healthy stands. In dwarf mistletoe-infested stands, the increase in average d.b.h. due to thinning will be half the change indicated in the table.*

Table A-5—Average diameters (inches) after partial cutting from below to various levels in Engelmann spruce-subalpine fir stands

Average D.B.H. Before Cutting (Inches)	Percentage of Trees Retained								
	10	20	30	40	50	60	70	80	90
1.0	1.5	1.4	1.3	1.2	1.2	1.1	1.1	1.1	1.1
2.0	3.0	2.7	2.6	2.5	2.3	2.3	2.2	2.2	2.1
3.0	4.5	4.1	3.8	3.7	3.5	3.4	3.3	3.2	3.1
4.0	6.0	5.4	5.1	4.9	4.6	4.5	4.4	4.3	4.2
5.0	7.5	6.7	6.3	6.1	5.8	5.6	5.5	5.3	5.2
6.0	8.9	8.1	7.6	7.3	6.9	6.8	6.6	6.4	6.2
7.0	10.4	9.4	8.8	8.5	8.1	7.9	7.7	7.5	7.2
8.0	11.8	10.7	10.1	9.7	9.3	9.0	8.8	8.5	8.3
9.0	13.3	12.0	11.3	10.8	10.4	10.1	9.9	9.6	9.3
10.0	14.7	13.3	12.5	12.0	11.6	11.3	11.0	10.6	10.3
11.0	16.2	14.6	13.8	13.2	12.7	12.4	12.0	11.7	11.4
12.0	17.6	15.9	15.0	14.4	13.9	13.5	13.1	12.8	12.4
13.0	19.1	17.2	16.2	15.6	15.0	14.6	14.2	13.8	13.4
14.0	20.5	18.5	17.5	16.7	16.2	15.7	15.3	14.9	14.5
15.0	22.0	19.8	18.7	17.9	17.3	16.9	16.4	16.0	15.5
16.0	23.4	21.1	19.9	19.1	18.5	18.0	17.5	17.0	16.5
17.0	24.8	22.4	21.1	20.3	19.6	19.1	18.6	18.1	17.6
18.0	26.3	23.7	22.4	21.4	20.8	20.2	19.7	19.1	18.6
19.0	27.7	25.0	23.6	22.6	21.9	21.4	20.8	20.2	19.6
20.0	29.1	26.3	24.8	23.8	23.1	22.5	21.9	21.3	20.6
21.0	30.6	27.6	26.0	24.9	24.3	23.6	23.0	22.3	21.7
22.0	32.0	28.9	27.2	26.1	25.4	24.7	24.1	23.4	22.7
23.0	33.4	30.2	28.4	27.3	26.6	25.9	25.2	24.4	23.7
24.0	34.9	31.5	29.7	28.4	27.7	27.0	26.2	25.5	24.8
25.0	36.3	32.8	30.9	29.6	28.9	28.1	27.3	26.6	25.8

Appendix 2

Output of Sample Problem

YIELDS PER ACRE OF BLACK HILLS PONDEROSA PINE

SAMPLE OUTPUT, RES. PAP. RM-79, P.19.

SITE INDEX, 70 FT. 20-YEAR THINNING INTERVAL
THINNING INTENSITY— INITIAL- 80.0 SUBSEQUENT- 80.0

		CHARACTERISTICS BEFORE AND AFTER THINNING							PERIODIC INTERMEDIATE CUTS						
STAND AGE YEARS	DMR	TREES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	AVERAGE HEIGHT FT.	TOTAL VOLUME CU.FT.	MERCH. VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.	TREES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	TOTAL VOLUME CU.FT.	MERCH. VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.	MERCH. CU.FT. SUBSAWLOG
30	.0	950	119	4.8	25	1220	300	0							
30	.0	288	57	6.0	27	630	300	0	662	62	4.1	590	0	0	0
40	.0	286	83	7.3	36	1230	920	0							
50	.0	284	107	8.3	45	1960	1680	1800							
50	.0	172	78	9.1	46	1460	1320	1800	112	29	6.9	500	360	0	360
60	.0	171	97	10.2	52	2070	1930	4800							
70	.0	171	115	11.1	59	2840	2660	9200							
70	.0	104	80	11.9	60	2030	1910	7500	67	35	9.8	810	750	1700	240
80	.0	104	96	13.0	65	2700	2550	10500							
90	.0	104	111	14.0	70	3400	3230	14400							
90	.0	67	80	14.8	71	2480	2360	10900	37	31	12.4	920	870	3500	0
100	.0	67	92	15.9	75	3050	2910	14400							
110	.0	67	104	16.9	79	3630	3470	18000							
110	.0	21	40	18.7	81	1430	1380	7500	46	64	16.0	2200	2090	10500	0
120	.0	21	47	20.3	84	1760	1700	9800							
130	.0	21	54	21.8	86	2100	2030	12400							
									TOTAL YIELDS			7120	6100	28100	360

MERCH. CU. FT. - TREES 6.0 INCHES D.B.H. AND LARGER TO 4.0-INCH TOP.
BD. FT. - TREES 10.0 INCHES D.B.H. AND LARGER TO 8.0-INCH TOP.
MINIMUM REMOVALS FOR INCLUSION IN TOTAL YIELDS—
320. CUBIC FEET AND 1500. BOARD FEET PER ACRE.
ALL THINNINGS MAY BE NONCOMMERCIAL.

YIELDS PER ACRE OF BLACK HILLS PONDEROSA PINE

SAMPLE OUTPUT, RES. PAP. RM-79, P.19.

SITE INDEX, 70 FT. 20-YEAR THINNING INTERVAL
THINNING INTENSITY— INITIAL- 80.0 SUBSEQUENT- 120.0

		CHARACTERISTICS BEFORE AND AFTER THINNING							PERIODIC INTERMEDIATE CUTS						
STAND AGE YEARS	DMR	TREES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	AVERAGE HEIGHT FT.	TOTAL VOLUME CU.FT.	MERCH. VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.	TREES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	TOTAL VOLUME CU.FT.	MERCH. VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.	MERCH. CU.FT. SUBSAWLOG
30	.0	950	119	4.8	25	1220	300	0							
30	.0	288	57	6.0	27	630	300	0	662	62	4.1	590	0	0	0
40	.0	286	83	7.3	36	1230	920	0							
50	.0	284	107	8.3	45	1960	1680	1400							
50	.0	284	107	8.3	45	1960	1680	1400	0	0	.0	0	0	0	0
60	.0	281	130	9.2	51	2720	2460	4500							
70	.0	276	148	9.9	58	3500	3240	8400							
70	.0	200	120	10.5	58	2930	2740	8000	76	28	8.2	570	500	400	370
80	.0	200	139	11.3	64	3800	3560	13500							
90	.0	200	157	12.0	69	4670	4390	17100							
90	.0	136	120	12.7	70	3600	3400	13800	64	37	10.3	1070	990	3300	40
100	.0	136	135	13.5	74	4350	4120	17900							
110	.0	136	150	14.2	77	5080	4820	22100							
110	.0	43	60	16.0	79	2100	2000	9800	93	90	13.3	2980	2820	12300	0
120	.0	43	70	17.3	82	2560	2460	12800							
130	.0	43	80	18.5	85	3040	2920	16100							
									TOTAL YIELDS			8250	7230	31700	370

MERCH. CU. FT. - TREES 6.0 INCHES D.B.H. AND LARGER TO 4.0-INCH TOP.
BD. FT. - TREES 10.0 INCHES D.B.H. AND LARGER TO 8.0-INCH TOP.
MINIMUM REMOVALS FOR INCLUSION IN TOTAL YIELDS—
320. CUBIC FEET AND 1500. BOARD FEET PER ACRE.
ALL THINNINGS MAY BE NONCOMMERCIAL.
NOTE THAT NOT ALL SCHEDULED THINNINGS WERE POSSIBLE.

YIELDS PER ACRE OF LODGEPOLE PINE

SAMPLE OUTPUT, RES. PAP. RM-72, P.12+13.

SITE INDEX, 70 FT. 20-YEAR THINNING INTERVAL
THINNING INTENSITY—INITIAL- 120.0 SUBSEQUENT- 80.0

		CHARACTERISTICS BEFORE AND AFTER THINNING							PERIODIC INTERMEDIATE CUTS						
STAND AGE YEARS	DMR	TREES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	AVERAGE HEIGHT FT.	TOTAL VOLUME CU.FT.	MERCH. VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.	TREES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	TOTAL VOLUME CU.FT.	MERCH. VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.	MERCH. CU.FT. SUBSAWLOG
30	.0	1000	110	4.5	28	1470	210	0							
30	.0	505	72	5.1	29	1010	210	0	495	38	3.8	460	0	0	0
40	.0	502	102	6.1	36	1850	970	0							
50	.0	500	130	6.9	41	2660	2000	0							
50	.0	218	70	7.7	42	1500	1270	0	282	60	6.2	1160	730	0	730
60	.0	216	91	8.8	50	2280	2070	8500							
70	.0	214	112	9.8	56	3140	2910	12300							
70	.0	136	80	10.4	56	2280	2140	9000	78	32	8.7	860	770	3300	0
80	.0	136	98	11.5	61	3000	2830	12400							
90	.0	136	116	12.5	65	3710	3520	15900							
90	.0	84	80	13.2	66	2560	2440	11200	52	36	11.3	1150	1080	4700	0
100	.0	84	94	14.3	70	3130	2990	14100							
110	.0	84	109	15.4	73	3760	3600	17300							
110	.0	56	80	16.2	73	2780	2670	13000	28	29	13.8	980	930	4300	0
120	.0	56	92	17.4	76	3300	3180	15900							
130	.0	56	105	18.5	78	3830	3690	18800							
									TOTAL YIELDS			8440	7200	31100	730

MERCH. CU. FT. - TREES 6.0 INCHES D.B.H. AND LARGER TO 4.0-INCH TOP.
BD. FT. - TREES 6.5 INCHES D.B.H. AND LARGER TO 6.0-INCH TOP.
MINIMUM REMOVALS FOR INCLUSION IN TOTAL YIELDS—
320. CUBIC FEET AND 1500. BOARD FEET PER ACRE.
INITIAL THINNING FROM ABOVE ALLOWED IN STANDS WITH DWARF MISTLETOE.
D.M.R. ABOVE WHICH PERIODIC THINNINGS WILL NOT BE EXECUTED - 3.0.
ALL THINNINGS MAY BE NONCOMMERCIAL.

YIELDS PER ACRE OF LODGEPOLE PINE

SAMPLE OUTPUT, RES. PAP. RM-72, P.12+13.

SITE INDEX, 70 FT. 20-YEAR THINNING INTERVAL
THINNING INTENSITY—INITIAL- 120.0 SUBSEQUENT- 100.0

		CHARACTERISTICS BEFORE AND AFTER THINNING							PERIODIC INTERMEDIATE CUTS						
STAND AGE YEARS	DMR	TREES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	AVERAGE HEIGHT FT.	TOTAL VOLUME CU.FT.	MERCH. VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.	TREES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	TOTAL VOLUME CU.FT.	MERCH. VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.	MERCH. CU.FT. SUBSAWLOG
30	.0	1000	110	4.5	28	1470	210	0							
30	.0	505	72	5.1	29	1010	210	0	495	38	3.8	460	0	0	0
40	.0	502	102	6.1	36	1850	970	0							
50	.0	500	130	6.9	41	2660	2000	0							
50	.0	282	87	7.5	42	1820	1500	0	218	43	6.0	840	500	0	500
60	.0	281	111	8.5	49	2740	2460	10100							
70	.0	281	135	9.4	55	3760	3480	14500							
70	.0	183	100	10.0	56	2810	2630	11100	98	35	8.1	950	850	3400	30
80	.0	183	119	10.9	61	3640	3430	14700							
90	.0	183	139	11.8	65	4470	4220	18700							
90	.0	117	100	12.5	66	3200	3040	13700	66	39	10.4	1270	1180	5000	0
100	.0	117	116	13.5	69	3890	3700	17100							
110	.0	117	132	14.4	72	4580	4370	20600							
110	.0	80	99	15.1	73	3450	3300	15800	37	33	12.8	1130	1070	4800	0
120	.0	80	115	16.2	75	4090	3920	19200							
130	.0	80	129	17.2	78	4720	4540	22600							
									TOTAL YIELDS			9370	8140	35800	500

MERCH. CU. FT. - TREES 6.0 INCHES D.B.H. AND LARGER TO 4.0-INCH TOP.
BD. FT. - TREES 6.5 INCHES D.B.H. AND LARGER TO 6.0-INCH TOP.
MINIMUM REMOVALS FOR INCLUSION IN TOTAL YIELDS—
320. CUBIC FEET AND 1500. BOARD FEET PER ACRE.
INITIAL THINNING FROM ABOVE ALLOWED IN STANDS WITH DWARF MISTLETOE.
D.M.R. ABOVE WHICH PERIODIC THINNINGS WILL NOT BE EXECUTED - 3.0.
ALL THINNINGS MAY BE NONCOMMERCIAL.

YIELDS PER ACRE OF SOUTHWESTERN PONDEROSA PINE **OVERSTORY**

SAMPLE OUTPUT, RES. PAP. RM-163, P.24. NO DELAY.

SITE INDEX, 70 FT. 20-YEAR THINNING INTERVAL
THINNING INTENSITY— INITIAL- 120.0 SUBSEQUENT- 90.0

	CHARACTERISTICS BEFORE AND AFTER THINNING								PERIODIC INTERMEDIATE CUTS						
STAND AGE YEARS	OMR	TREES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	AVERAGE HEIGHT FT.	TOTAL VOLUME CU.FT.	MERCH. VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.	TREES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	TOTAL VOLUME CU.FT.	MERCH. VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.	MERCH. CU.FT. SUBSAWLOG
150	4.8	20	28	16.1	75	800	760	3300							
									TOTAL YIELDS			800	760	3300	0

MERCH. CU. FT. - TREES 6.0 INCHES D.B.H. AND LARGER TO 4.0-INCH TOP.
BD. FT. - TREES 10.0 INCHES D.B.H. AND LARGER TO VARIABLE TOP LIMIT.
MINIMUM REMOVALS FOR INCLUSION IN TOTAL YIELDS—
320. CUBIC FEET AND 1500. BOARD FEET PER ACRE.
INITIAL THINNING FROM ABOVE ALLOWED IN STANDS WITH DWARF MISTLETOE.
D.M.R. ABOVE WHICH PERIODIC THINNINGS WILL NOT BE EXECUTED - 3.0.
PRECOMMERCIAL INITIAL THINNING ALLOWED. NONCOMMERCIAL SUBSEQUENT THINNINGS NOT ALLOWED.

YIELDS PER ACRE OF SOUTHWESTERN PONDEROSA PINE **UNDERSTORY**

SAMPLE OUTPUT, RES. PAP. RM-163, P.24. NO DELAY.

SITE INDEX, 70 FT. 20-YEAR THINNING INTERVAL
THINNING INTENSITY— INITIAL- 120.0 SUBSEQUENT- 90.0

STAND AGE YEARS	OMR	TREES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	AVERAGE HEIGHT FT.	TOTAL VOLUME CU.FT.	MERCH. VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.	TREES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	TOTAL VOLUME CU.FT.	MERCH. VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.	MERCH. CU.FT. SUBSAWLOG
30	1.0	600	55	4.1	21	710	0	0							
30	.5	513	43	3.9	20	560	0	0	87	12	5.0	150	0	0	0
40	.9	510	78	5.3	29	1020	330	0							
50	1.4	504	109	6.3	38	1630	940	0							
50	1.4	504	109	6.3	38	1630	940	0	0	0	.0	0	0	0	0
60	2.3	445	122	7.1	44	2020	1450	0							
70	3.2	376	128	7.9	50	2330	1870	0							
70	3.2	376	128	7.9	50	2330	1870	0	0	0	.0	0	0	0	0
80	4.0	304	123	8.6	56	2410	2050	1900							
90	4.9	235	111	9.3	60	2360	2070	3100							
90	4.9	235	111	9.3	60	2360	2070	3100	0	0	.0	0	0	0	0
100	5.3	174	95	10.0	62	2140	1910	3900							
110	5.8	126	79	10.7	64	1850	1680	4500							
110	5.0	58	45	11.9	66	1080	1000	3500	68	34	9.6	770	680	1000	450
120	5.3	44	41	13.1	68	1040	960	3700							
130	5.7	33	36	14.2	69	940	880	3500							
									TOTAL YIELDS			1860	1560	3500	450

MERCH. CU. FT. - TREES 6.0 INCHES D.B.H. AND LARGER TO 4.0-INCH TOP.
BD. FT. - TREES 10.0 INCHES D.B.H. AND LARGER TO VARIABLE TOP LIMIT.
MINIMUM REMOVALS FOR INCLUSION IN TOTAL YIELDS—
320. CUBIC FEET AND 1500. BOARD FEET PER ACRE.
INITIAL THINNING FROM ABOVE ALLOWED IN STANDS WITH DWARF MISTLETOE.
D.M.R. ABOVE WHICH PERIODIC THINNINGS WILL NOT BE EXECUTED - 3.0.
PRECOMMERCIAL INITIAL THINNING ALLOWED. NONCOMMERCIAL SUBSEQUENT THINNINGS NOT ALLOWED.
NOTE THAT NOT ALL SCHEDULED THINNINGS WERE POSSIBLE.

YIELDS PER ACRE OF SOUTHWESTERN PONDEROSA PINE **OVERSTORY**

SAMPLE OUTPUT. RES. PAP. RM-163, P.25. 20-YR DELAY

SITE INDEX, 70 FT. 20-YEAR THINNING INTERVAL
THINNING INTENSITY— INITIAL- 120.0 SUBSEQUENT- 90.0

CHARACTERISTICS BEFORE AND AFTER THINNING									PERIODIC INTERMEDIATE CUTS						
STAND AGE YEARS	DMR	TREES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	AVERAGE HEIGHT FT.	TOTAL VOLUME CU.FT.	MERCH. VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.	TREES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	TOTAL VOLUME CU.FT.	MERCH. VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.	MERCH. CU.FT. SUBSAWLOG
150	4.8	20	28	16.1	75	800	760	3300							
160	5.0	16	25	17.0	76	730	700	3200							
170	5.2	12	21	17.8	77	610	580	2700							
									TOTAL YIELDS			610	580	2700	0

MERCH. CU. FT. - TREES 6.0 INCHES D.B.H. AND LARGER TO 4.0-INCH TOP.
BD. FT. - TREES 10.0 INCHES D.B.H. AND LARGER TO VARIABLE TOP LIMIT.
MINIMUM REMOVALS FOR INCLUSION IN TOTAL YIELDS—
320. CUBIC FEET AND 1500. BOARD FEET PER ACRE.
INITIAL THINNING FROM ABOVE ALLOWED IN STANDS WITH DWARF MISTLETOE.
D.M.R. ABOVE WHICH PERIODIC THINNINGS WILL NOT BE EXECUTED - 3.0.
PRECOMMERCIAL INITIAL THINNING ALLOWED. NONCOMMERCIAL SUBSEQUENT THINNINGS NOT ALLOWED.

YIELDS PER ACRE OF SOUTHWESTERN PONDEROSA PINE **UNDERSTORY**

SAMPLE OUTPUT, RES. PAP. RM-163, P.25. 20-YR DELAY

SITE INDEX, 70 FT. 20-YEAR THINNING INTERVAL
THINNING INTENSITY— INITIAL- 120.0 SUBSEQUENT- 90.0

CHARACTERISTICS BEFORE AND AFTER THINNING									PERIODIC INTERMEDIATE CUTS						
STAND AGE YEARS	DMR	TREES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	AVERAGE HEIGHT FT.	TOTAL VOLUME CU.FT.	MERCH. VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.	TREES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	TOTAL VOLUME CU.FT.	MERCH. VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.	MERCH. CU.FT. SUBSAWLOG
30	1.0	600	55	4.1	21	710	0	0							
40	1.5	538	76	5.1	29	1040	290	0							
50	2.5	471	92	6.0	38	1400	710	0							
50	1.6	276	46	5.5	36	690	260	0	195	46	6.6	710	450	0	450
60	2.5	244	63	6.9	42	1010	700	0							
70	3.3	207	74	8.1	49	1300	1060	400							
70	3.3	207	74	8.1	49	1300	1060	400	0	0	.0	0	0	0	0
80	4.2	168	78	9.2	54	1470	1280	1600							
90	5.0	130	74	10.2	58	1530	1380	3000							
90	5.0	130	74	10.2	58	1530	1380	3000	0	0	.0	0	0	0	0
100	5.5	97	65	11.1	60	1430	1310	4000							
110	5.9	71	56	12.0	62	1280	1180	4200							
110	5.7	51	45	12.7	63	1040	970	3600	20	11	10.0	240	210	600	80
120	6.0-	37	38	13.7	64	910	850	3300							
130	6.0-	28	29	13.7	64	690	640	2500							
									TOTAL YIELDS			1640	1090	2500	450

MERCH. CU. FT. - TREES 6.0 INCHES D.B.H. AND LARGER TO 4.0-INCH TOP.
BD. FT. - TREES 10.0 INCHES D.B.H. AND LARGER TO VARIABLE TOP LIMIT.
MINIMUM REMOVALS FOR INCLUSION IN TOTAL YIELDS—
320. CUBIC FEET AND 1500. BOARD FEET PER ACRE.
INITIAL THINNING FROM ABOVE ALLOWED IN STANDS WITH DWARF MISTLETOE.
D.M.R. ABOVE WHICH PERIODIC THINNINGS WILL NOT BE EXECUTED - 3.0.
PRECOMMERCIAL INITIAL THINNING ALLOWED. NONCOMMERCIAL SUBSEQUENT THINNINGS NOT ALLOWED.
NOTE THAT NOT ALL SCHEDULED THINNINGS WERE POSSIBLE.

YIELDS PER ACRE OF ENGELMANN SPRUCE AND SUBALPINE FIR

SAMPLE OUTPUT, RES. PAP. RM-134, P.16.

SITE INDEX, 80 FT. 30-YEAR THINNING INTERVAL
THINNING INTENSITY— INITIAL- 120.0 SUBSEQUENT- 80.0

		CHARACTERISTICS BEFORE AND AFTER THINNING							PERIODIC INTERMEDIATE CUTS						
STAND AGE YEARS B.H.	DMR	TREES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	AVERAGE HEIGHT FT.	TOTAL VOLUME CU.FT.	MERCH. VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.	TREES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	TOTAL VOLUME CU.FT.	MERCH. VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.	MERCH. CU.FT. SUBSAWLOG
30	.0	850	94	4.5	28	1140	350	0							
30	.0	505	72	5.1	29	880	350	0	345	22	3.4	260	0	0	0
40	.0	498	108	6.3	37	1620	1050	0							
50	.0	485	141	7.3	45	2540	1940	0							
60	.0	466	175	8.3	52	3660	3040	8700							
60	.0	133	80	10.5	53	1840	1660	6300	333	95	7.2	1820	1380	2400	750
70	.0	133	101	11.8	60	2590	2400	10000							
80	.0	133	124	13.1	65	3480	3280	14500							
90	.0	133	148	14.3	70	4460	4240	19600							
90	.0	50	81	17.2	71	2490	2400	11800	83	67	12.2	1970	1840	7800	0
100	.0	50	95	18.7	76	3000	2920	14900							
110	.0	50	111	20.2	80	3600	3510	18500							
120	.0	50	128	21.7	83	4250	4170	22700							
120	.0	16	62	26.7	84	2050	2030	11500	34	66	18.9	2200	2140	11200	0
130	.0	16	71	28.6	87	2410	2380	13900							
140	.0	16	82	30.6	90	2820	2790	16700							
150	.0	16	93	32.6	92	3260	3230	19700							
									TOTAL YIELDS			9510	8590	41100	750

MERCH. CU. FT. - TREES 5.0 INCHES D.B.H. AND LARGER TO 4.0-INCH TOP.
BD. FT. - TREES 8.0 INCHES D.B.H. AND LARGER TO 6.0-INCH TOP.
MINIMUM REMOVALS FOR INCLUSION IN TOTAL YIELDS—
400. CUBIC FEET AND 2000. BOARD FEET PER ACRE.
ALL THINNINGS MAY BE NONCOMMERCIAL.

YIELDS PER ACRE OF ENGELMANN SPRUCE AND SUBALPINE FIR

SAMPLE OUTPUT, RES. PAP. RM-134, P.16.

SITE INDEX, 80 FT. 30-YEAR THINNING INTERVAL
THINNING INTENSITY— INITIAL- 120.0 SUBSEQUENT- 120.0

		CHARACTERISTICS BEFORE AND AFTER THINNING							PERIODIC INTERMEDIATE CUTS						
STAND AGE YEARS B.H.	DMR	TREES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	AVERAGE HEIGHT FT.	TOTAL VOLUME CU.FT.	MERCH. VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.	TREES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	TOTAL VOLUME CU.FT.	MERCH. VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.	MERCH. CU.FT. SUBSAWLOG
30	.0	850	94	4.5	28	1140	350	0							
30	.0	505	72	5.1	29	880	350	0	345	22	3.4	260	0	0	0
40	.0	498	108	6.3	37	1620	1050	0							
50	.0	485	141	7.3	45	2540	1940	0							
60	.0	466	175	8.3	52	3660	3040	8700							
60	.0	237	119	9.6	53	2640	2330	8200	229	56	6.7	1020	710	500	570
70	.0	227	142	10.7	59	3520	3200	12600							
80	.0	227	172	11.8	65	4690	4350	18500							
90	.0	227	203	12.8	70	5940	5570	24900							
90	.0	95	120	15.2	71	3620	3460	16300	132	83	10.7	2320	2110	8600	0
100	.0	95	141	16.5	75	4540	4370	21500							
110	.0	95	164	17.8	79	5330	5160	26400							
120	.0	95	189	19.1	82	6260	6090	32100							
120	.0	33	97	23.2	83	3190	3160	17300	62	92	16.5	3070	2930	14800	0
130	.0	33	112	24.9	86	3760	3720	21000							
140	.0	33	127	26.6	89	4380	4330	25100							
150	.0	33	144	28.3	91	5040	4990	29600							
									TOTAL YIELDS			11710	10740	53000	570

MERCH. CU. FT. - TREES 5.0 INCHES D.B.H. AND LARGER TO 4.0-INCH TOP.
BD. FT. - TREES 8.0 INCHES D.B.H. AND LARGER TO 6.0-INCH TOP.
MINIMUM REMOVALS FOR INCLUSION IN TOTAL YIELDS—
400. CUBIC FEET AND 2000. BOARD FEET PER ACRE.
ALL THINNINGS MAY BE NONCOMMERCIAL.

Edminster, Carleton B. 1978. RMYLD: Computation of yield tables for even-aged and two-storied stands. Res. Pap. RM-199, 26 p. Rocky Mt. For. and Range Exp. Stn., For. Serv., U.S. Dep. Agric., Fort Collins, Colo. 80521.

Documents a program for computation of yield tables for even-aged and two-storied stands of Black Hills and southwestern ponderosa pine, Engelmann spruce-subalpine fir, and even-aged stands of lodgepole pine. Alternatives include a wide range of stand densities and management controls. Program relationships provide for changes in stand conditions and severity of dwarf mistletoe infestation with time and in response to partial cuttings. Supersedes programs LPMIST, PONYLD, SPRYLD, and SWYLD2, published as USDA For. Serv. Res. Pap. RM-72 (1971), RM-79 (1971), RM-134 (1975), and RM-163 (1976). Also supersedes USDA For. Serv. Res. Pap. RM-21 (1966), RM-26 (1967), RM-43 (1968), and RM-87 (1972).

Keywords: Stand yield tables, forest management, *Pinus contorta, Pinus ponderosa, Picea engelmannii, Abies lasiocarpa*.

Edminster, Carleton B. 1978. RMYLD: Computation of yield tables for even-aged and two-storied stands. Res. Pap. RM-199, 26 p. Rocky Mt. For. and Range Exp. Stn., For. Serv., U.S. Dep. Agric., Fort Collins, Colo. 80521.

Documents a program for computation of yield tables for even-aged and two-storied stands of Black Hills and southwestern ponderosa pine, Engelmann spruce-subalpine fir, and even-aged stands of lodgepole pine. Alternatives include a wide range of stand densities and management controls. Program relationships provide for changes in stand conditions and severity of dwarf mistletoe infestation with time and in response to partial cuttings. Supersedes programs LPMIST, PONYLD, SPRYLD, and SWYLD2, published as USDA For. Serv. Res. Pap. RM-72 (1971), RM-79 (1971), RM-134 (1975), and RM-163 (1976). Also supersedes USDA For. Serv. Res. Pap. RM-21 (1966), RM-26 (1967), RM-43 (1968), and RM-87 (1972).

Keywords: Stand yield tables, forest management, *Pinus contorta, Pinus ponderosa, Picea engelmannii, Abies lasiocarpa*.

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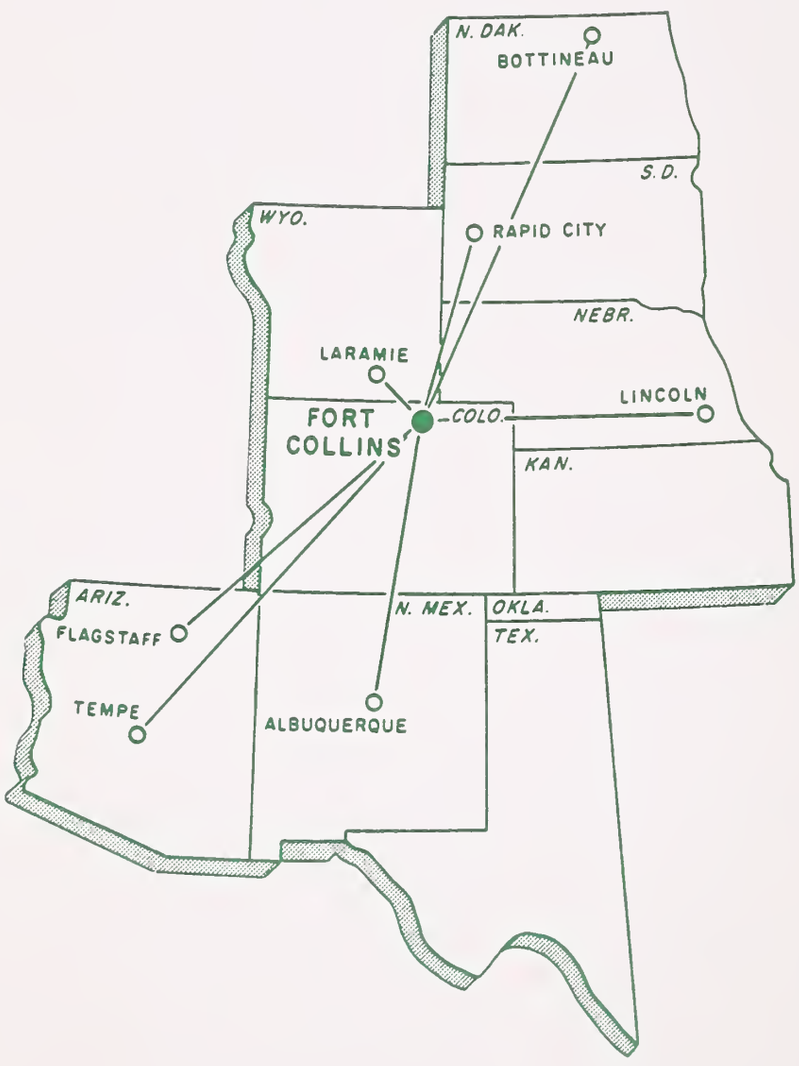
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